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     (FILE 'HOME' ENTERED AT 16:19:06 ON 10 AUG 2005)

     FILE 'CAPLUS, USPATFULL' ENTERED AT 16:19:25 ON 10 AUG 2005
L1             61 S FUEL (W) CELL AND (LYASE OR CLOSTRIDI?)
L2             28 S FUEL (W) CELL AND (FORMATE (W) HYDROGEN (W) LYASE OR CLOSTRID
L3              1 S FUEL (W) CELL AND (FORMATE (W) HYDROGEN (W) LYASE AND CLOSTRI

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L2 ANSWER 1 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Bad date

Full Text | Citing References

ACCESSION NUMBER: 2005:141224 CAPLUS
DOCUMENT NUMBER: 142:238780
TITLE: A composite layered biostructure containing a phototrophic genetically engineered Rhodopseudomonas palustris or other microbe for the production of hydrogen
INVENTOR(S): Flickinger, Michael C.; Rey, Federico; Harwood, Caroline S.
PATENT ASSIGNEE(S): Regents of the University of Minnesota, USA; University of Iowa Research Foundation
SOURCE: PCT Int. Appl., 61 pp.
CODEN: PIXXD2
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|---|---|---|---|---|
| WO 2005014805 | A1 | 20050217 | WO 2004-US26257 | 20040809 |

W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW

RW: BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG

PRIORITY APPLN. INFO.: US 2003-493745P P 20030808
REFERENCE COUNT: 7 THERE ARE 7 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

IT **Fuel cells**
(biochem. **fuel cells**; composite layered biostructure contg. phototrophic genetically engineered Rhodopseudomonas palustris or other microbe for hydrogen prodn.)

IT Algae
Biological materials
Carbon sources, microbial
Chlamydomonas
**Clostridium butyricum**
Coating materials
Coating process
Composites
Electric conductors
Fermentation
Genetic engineering
Geobacter
Immobilization, molecular or cellular
Microorganism
Optical absorption
Rhodobacter
Rhodococcus
Rhodopseudomonas palustris
Rubrivivax

Transparent materials
(composite layered biostructure contg. phototrophic genetically engineered Rhodopseudomonas palustris or other microbe for hydrogen prodn.)

L2 ANSWER 2 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Bad date

Full Text | Citing References

ACCESSION NUMBER: 2004:667352 CAPLUS
DOCUMENT NUMBER: 141:409882
TITLE: Exploiting complex carbohydrates for microbial electricity generation - a bacterial **fuel cell** operating on starch
AUTHOR(S): Niessen, Juliane; Schroeder, Uwe; Scholz, Fritz
CORPORATE SOURCE: Institut fuer Chemie und Biochemie, Universitaet Greifswald, Greifswald, 17489, Germany
SOURCE: Electrochemistry Communications (2004), 6(9), 955-958
CODEN: ECCMF9; ISSN: 1388-2481
PUBLISHER: Elsevier B.V.
DOCUMENT TYPE: Journal
LANGUAGE: English
REFERENCE COUNT: 16 THERE ARE 16 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

TI Exploiting complex carbohydrates for microbial electricity generation - a bacterial **fuel cell** operating on starch

AB In this contribution we demonstrate that by combining specially designed anodes, consisting of platinum covered by poly(tetrafluoroaniline) and living cells of the biocatalyst **Clostridium butyricum** or Clostridium beijerinckii electricity can be generated from a variety of substrates, including starch, one of the major biomass constituents. Current densities between 1 and 1.3 mA cm-2 are achieved by using glucose, molasses, or starch as fuel.

ST bacterial **fuel cell** electricity generation

IT Electric energy
(biochem.; exploiting complex carbohydrates for microbial electricity generation - bacterial **fuel cell** operating on starch)

IT Anodes
Clostridium beijerinckii
**Clostridium butyricum**
Current density
Fermentation
Molasses
(exploiting complex carbohydrates for microbial electricity generation - bacterial **fuel cell** operating on starch)

IT Immobilization, molecular or cellular
(microbial cell; exploiting complex carbohydrates for microbial electricity generation - bacterial **fuel cell** operating on starch)

IT 50-21-5, Lactic acid, processes 50-99-7, D-Glucose, processes 9005-25-8, Starch, processes
RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process)
(exploiting complex carbohydrates for microbial electricity generation - bacterial **fuel cell** operating on starch)

IT 163969-95-7
RL: BUU (Biological use, unclassified); BIOL (Biological study); USES (Uses)
(exploiting complex carbohydrates for microbial electricity generation - bacterial **fuel cell** operating on starch)

L2 ANSWER 3 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

Bad date

ACCESSION NUMBER: 2002:714426 CAPLUS
DOCUMENT NUMBER: 137:250255
TITLE: Polymer electrolyte **fuel cell** set
INVENTOR(S): Yamamoto, Noriyuki; Yoneda, Tetsuya; Nishimura, Kazuhito; Komota, Mutsuko; Satomura, Masashi
PATENT ASSIGNEE(S): Sharp Corp., Japan
SOURCE: Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DOCUMENT TYPE: Patent
LANGUAGE: Japanese
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|---|---|---|---|---|
| JP 2002270210 | A2 | 20020920 | JP 2001-62411 | 20010306 |

PRIORITY APPLN. INFO.: JP 2001-62411 20010306

TI Polymer electrolyte **fuel cell** set

AB The **fuel cell** set has a **fuel cell**, having a polymer electrolyte membrane between a cathode and an anode, inside a container having a fuel inlet, a fuel cartridge contg. a chamber for an O contg. hydrocarbon fuel and a catalytic chamber contg. a biocatalyst producing H from the O contg. hydrocarbon, and a pipe, having 1 end connectable to the fuel inlet of the container and the other end insert-able in the fuel cartridge; where the other end penetrates both chambers in the cartridge and has ?1 open holes. The O contg. hydrocarbon is an alc., aldehyde, ketone, or carboxylic acid; and the biocatalyst is **clostridium butyricum** or formate dehydrogenase.

ST polymer electrolyte **fuel cell** biocatalytic hydrogen supply; alc biocatalytic hydrogen supply **fuel cell**; aldehyde biocatalytic hydrogen supply **fuel cell**; ketone biocatalytic hydrogen supply **fuel cell**; carboxylic acid biocatalytic hydrogen supply **fuel cell**; **clostridium butyricum** biocatalyst hydrogen supply **fuel cell**; formate dehydrogenase biocatalyst hydrogen supply **fuel cell**

IT **Clostridium butyricum**
  **Fuel cells**
    (polymer electrolyte **fuel cells** using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)

IT Alcohols, processes
  Aldehydes, processes
  Carboxylic acids, processes
  Ketones, processes
  RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process)
    (polymer electrolyte **fuel cells** using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)

IT 67-56-1, Methanol, processes
  RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process)
    (polymer electrolyte **fuel cells** using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)

IT 9028-85-7, Formate dehydrogenase
  RL: CAT (Catalyst use); USES (Uses)
    (polymer electrolyte **fuel cells** using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)

IT 1333-74-0P, Hydrogen, preparation
  RL: IMF (Industrial manufacture); PREP (Preparation)
    (polymer electrolyte **fuel cells** using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)

L2 ANSWER 4 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN INSTANT APP.

Full Text | Citing References

ACCESSION NUMBER: 2002:696508 CAPLUS
DOCUMENT NUMBER: 137:204025
TITLE: Polymer electrolyte **fuel cell**
INVENTOR(S): Yamamoto, Noriyuki; Katoh, Nobuo; Yukawa, Hideaki
PATENT ASSIGNEE(S): Japan
SOURCE: U.S. Pat. Appl. Publ., 7 pp.
CODEN: USXXCO
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | | DATE |
|---|---|---|---|---|---|
| US 2002127440 | A1 | 20020912 | US 2002-87994 | | 20020305 |
| JP 2002270209 | A2 | 20020920 | JP 2001-62403 | | 20010306 |
| PRIORITY APPLN. INFO.: | | | JP 2001-62403 | A | 20010306 |

TI Polymer electrolyte **fuel cell**

AB A polymer electrolyte **fuel cell** includes a housing provided with an anode-side supply inlet for supplying a material for fuel, an anode and a cathode accommodated in the housing to sandwich a polymer electrolyte membrane, and a layer contg. a biochem. catalyst which decomps. the material for fuel to generate fuel, the layer being formed between the anode-side supply inlet and the anode.

ST **fuel cell** polymer electrolyte

IT Catalysts
(biochem.; polymer electrolyte **fuel cell**)

IT Polyoxyalkylenes, uses
RL: DEV (Device component use); USES (Uses)
(fluorine- and sulfo-contg., ionomers; polymer electrolyte **fuel cell**)

IT Anaerobic bacteria
Yeast
(hydrogen-generative; polymer electrolyte **fuel cell**)

IT Enzymes, uses
RL: CAT (Catalyst use); USES (Uses)
(hydrogen-generative; polymer electrolyte **fuel cell**)

IT **Clostridium butyricum**
(polymer electrolyte **fuel cell**)

IT Alcohols, uses
Aldehydes, uses
Carboxylic acids, uses
Ketones, uses
Polysaccharides, uses
RL: TEM (Technical or engineered material use); USES (Uses)
(polymer electrolyte **fuel cell**)

IT Fluoropolymers, uses
RL: DEV (Device component use); USES (Uses)
(polyoxyalkylene-, sulfo-contg., ionomers; polymer electrolyte **fuel cell**)

IT Ionomers
RL: DEV (Device component use); USES (Uses)
(polyoxyalkylenes, fluorine- and sulfo-contg.; polymer electrolyte **fuel cell**)

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IT    Fuel cells
         (solid electrolyte; polymer electrolyte fuel cell)
IT    1333-74-0P, Hydrogen, uses
      RL: BPN (Biosynthetic preparation); TEM (Technical or engineered material
      use); BIOL (Biological study); PREP (Preparation); USES (Uses)
         (polymer electrolyte fuel cell)
IT    9028-85-7, Formate hydrogenlyase
      RL: CAT (Catalyst use); USES (Uses)
         (polymer electrolyte fuel cell)
IT    7440-06-4, Platinum, uses
      RL: CAT (Catalyst use); DEV (Device component use); USES (Uses)
         (polymer electrolyte fuel cell)
IT    7440-44-0, Carbon, uses
      RL: DEV (Device component use); USES (Uses)
         (polymer electrolyte fuel cell)

L2    ANSWER 5 OF 28   CAPLUS   COPYRIGHT 2005 ACS on STN          ?
Full Text | Citing References
ACCESSION NUMBER:          2002:487963  CAPLUS
DOCUMENT NUMBER:           137:67449
TITLE:                     Integrated anaerobic digester system
INVENTOR(S):               Ainsworth, Jack L.; Atwood, Dan; Rideout, Tom
PATENT ASSIGNEE(S):        USA
SOURCE:                    U.S. Pat. Appl. Publ., 20 pp., Cont.-in-part of U.S.
                           Ser. No. 602,684.
                           CODEN: USXXCO
DOCUMENT TYPE:             Patent
LANGUAGE:                  English
FAMILY ACC. NUM. COUNT:    2
PATENT INFORMATION:

      PATENT NO.          KIND   DATE        APPLICATION NO.        DATE
      ---------------     ----   --------    --------------------   --------
      US 2002079266        A1    20020627    US 2001-963130          20010924
      US 6569332           B2    20030527
      US 6299774           B1    20011009    US 2000-602684          20000626
      CA 2461395           AA    20030522    CA 2001-2461395         20011130
      WO 2003042117        A1    20030522    WO 2001-US45224         20011130
          W:  AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN,
              CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
              GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,
              LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH,
              PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA,
              UG, US, UZ, VN, YU, ZA, ZM, ZW
          RW: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY,
              KG, KZ, MD, RU, TJ, TM, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB,
              GR, IE, IT, LU, MC, NL, PT, SE, TR, BF, BJ, CF, CG, CI, CM, GA,
              GN, GQ, GW, ML, MR, NE, SN, TD, TG
      EP 1446358           A1    20040818    EP 2001-987178          20011130
          R:  AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT,
              IE, SI, LT, LV, FI, RO, MK, CY, AL, TR
PRIORITY APPLN. INFO.:                       US 2000-602684      A2 20000626
                                             US 2001-963130      A  20010924
                                             WO 2001-US45224     W  20011130

IT    Actuators
      Aerators
      Air conditioners
      Bacillus (bacterium genus)
      Clostridium
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**Clostridium butyricum**
Clostridium propionicum
Clostridium saccharoacetoperbutylicum
Combustion engines
Compressors
Conveyors
Cooling apparatus
Electric motors
Escherichia
Eubacteria
**Fuel cells**
Furnaces
Heat exchangers
Manure
Methanobacterium
Methanobacterium formicicum
Methanobacterium omelianskii
Methanobacterium propionicum
Methanobacterium soehngenii
Methanobacterium suboxydans
Methanobrevibacter ruminantium
Methanococcus vannielii
Methanomicrobium mobile
Methanomonas methanica
Methanosarcina acetivorans
Methanosarcina alcaliphilus
Methanosarcina barkeri
Methanosarcina mazei
Methanosarcina thermophila
Methanosarcina vacuolata
Methanothermobacter thermautotrophicus
Pressure sensors
Propionibacterium acidipropionici
Pumps
Saccharomyces cerevisiae
Saccharomyces ellipsoideus
Sarcina methanica
Staphylococcus
Thermoregulators
Wastes
(integrated anaerobic digester system for converting cellulose-contg. feedstock into useful materials)

L2 ANSWER 6 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 2002:102076 CAPLUS
DOCUMENT NUMBER: 136:382790
TITLE: A novel electrochemically active and Fe(III)-reducing bacterium phylogenetically related to **Clostridium butyricum** isolated from a microbial **fuel cell**
AUTHOR(S): Park, Hyung Soo; Kim, Byung Hong; Kim, Hyo Suk; Kim, Hyung Joo; Kim, Gwang Tae; Kim, Mia; Chang, In Seop; Park, Yong Keun; Chang, Hyo Ihl
CORPORATE SOURCE: Water Environment Research Centre, Korea Institute of Science and Technology, Hawolgok-dong, Sungpook-ku, Seoul, 136-791, S. Korea
SOURCE: Anaerobe (2001), 7(6), 297-306
CODEN: ANAEF8; ISSN: 1075-9964
PUBLISHER: Academic Press

DOCUMENT TYPE: Journal
LANGUAGE: English
REFERENCE COUNT: 37 THERE ARE 37 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

TI A novel electrochemically active and Fe(III)-reducing bacterium phylogenetically related to **Clostridium butyricum** isolated from a microbial **fuel cell**

AB An obligatory anaerobic bacterium was isolated from a mediator-less microbial **fuel cell** using starch processing wastewater as the fuel and designated as EG3. The isolate was Gram-pos., motile and rod (2.8-3.0 µm long, 0.5-0.6 µm wide). The partial 16S rRNA gene sequence and anal. of the cellular fatty acids profile suggested that EG3 clusters with Clostridium sub-phylum and exhibited the highest similarity (98%) with **Clostridium butyricum**. The temp. and pH optimum for growth were 37?C and 7.0, resp. The major products of glucose and glucose/Fe(O)OH metab. were lactate, formate, butyrate, acetate, CO2and H2. Growth was faster at the initial phase and the cell yield was higher when the medium was supplemented with Fe(O)OH than without Fe(O)OH. These results suggest that Fe(III) ion is utilized as an electron sink. Cyclic voltammetry showed that **Clostridium butyricum** EG3 cells were electrochem. active. It is a novel characteristic of strict anaerobic Gram-pos. bacteria. (c) 2001 Academic Press.

IT **Clostridium butyricum**
Evolution
Growth, microbial
Metabolism, microbial
Ribotyping
Taxonomy
(novel electrochem. active and iron-reducing bacterium phylogenetically related to **Clostridium butyricum** isolated from microbial **fuel cell**)

IT Fatty acids, biological studies
RL: BSU (Biological study, unclassified); BIOL (Biological study)
(novel electrochem. active and iron-reducing bacterium phylogenetically related to **Clostridium butyricum** isolated from microbial **fuel cell**)

IT 7439-89-6, Iron, biological studies
RL: BSU (Biological study, unclassified); BIOL (Biological study)
(novel electrochem. active and iron-reducing bacterium phylogenetically related to **Clostridium butyricum** isolated from microbial **fuel cell**)

L2 ANSWER 7 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

check

bacteria in liquid.

ACCESSION NUMBER: 2001:21517 CAPLUS
DOCUMENT NUMBER: 134:88628
TITLE: Apparatus for reforming hydrocarbon fuel gases to produce hydrogen
INVENTOR(S): Naito, Takeshi
PATENT ASSIGNEE(S): Nissan Motor Co., Ltd., Japan
SOURCE: Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DOCUMENT TYPE: Patent
LANGUAGE: Japanese
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
| --- | --- | --- | --- | --- |

| | | | | |
|---|---|---|---|---|
| JP 2001003822 | A2 | 20010109 | JP 1999-173846 | 19990621 |
| PRIORITY APPLN. INFO.: | | | JP 1999-173846 | 19990621 |

ST reforming hydrocarbon gas hydrogen prodn **fuel cell**
IT Clostridium acetobutylicum
**Clostridium butyricum**
Clostridium lactoacetophilum
**Fuel cells**
(app. for reforming hydrocarbon fuel gases to produce hydrogen by using Clostridium-series bacteria)

L2 ANSWER 8 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN
Full Text | Citing References

ACCESSION NUMBER: 1985:490301 CAPLUS
DOCUMENT NUMBER: 103:90301
TITLE: Manufacture of hydrogen using microorganisms
AUTHOR(S): Wakao, Noriaki
CORPORATE SOURCE: Coll. Eng., Yokohama Natl. Univ., Yokohama, Japan
SOURCE: Kemikaru Enjiniyaringu (1985), 30(6), 410-13
CODEN: KEENAT; ISSN: 0387-1037
DOCUMENT TYPE: Journal; General Review
LANGUAGE: Japanese

AB A review, with 8 refs., on H generation from weed and tree leaves by Enterobacter aerogenes 82005, and from alc. fermn. wastewater by **Clostridium butyricum**. The use of the H for **fuel cell** is also discussed.
ST hydrogen manuf microorganism review; biomass fermn hydrogen manuf review; weed fermn hydrogen manuf review; Enterobacter aerogenes hydrogen manuf review; **Clostridium butyricum** hydrogen manuf review; wastewater fermn hydrogen manuf review; **fuel cell** hydrogen review
IT **Fuel cells**
(hydrogen for)
IT **Clostridium butyricum**
(hydrogen manuf. from alc.-fermn. wastewater by)

L2 ANSWER 9 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN
Full Text | Citing References

ACCESSION NUMBER: 1984:441020 CAPLUS
DOCUMENT NUMBER: 101:41020
TITLE: Electrochemical conversion in biofuel cells using **Clostridium butyricum** or Staphylococcus aureus Oxford
AUTHOR(S): Ardeleanu, Ioan; Margineanu, Doru Georg; Vais, Horia
CORPORATE SOURCE: Membr. Biophys. Group, Inst. Biol. Sci., Bucharest, 79651, Rom.
SOURCE: Bioelectrochemistry and Bioenergetics (1983), 11(4-6), 273-7
CODEN: BEBEBP; ISSN: 0302-4598
DOCUMENT TYPE: Journal
LANGUAGE: English

TI Electrochemical conversion in biofuel cells using **Clostridium butyricum** or Staphylococcus aureus Oxford
ST biochem **fuel cell Clostridium butyricum**; Stphylococcus aureus biochem **fuel cell**; methylene blue biofuel cell; Hb biofuel cell
IT **Fuel cells**
(bio-, using **Clostridium butyricum** or Staphylococcus aureus)
IT **Clostridium butyricum**
Staphylococcus aureus
(biofuel cells using)

order

L2 ANSWER 10 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text · Citing References

ACCESSION NUMBER: 1984:409926 CAPLUS
DOCUMENT NUMBER: 101:9926
TITLE: Energy production with immobilized cells
AUTHOR(S): Suzuki, Shuichi; Karube, Isao
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, Japan
SOURCE: Applied Biochemistry and Bioengineering (1983), 4, 281-310
CODEN: ABBID7; ISSN: 0147-0248
DOCUMENT TYPE: Journal; General Review
LANGUAGE: English

AB A review with 28 refs. Immobilization of H- and CH4 [74-82-8]-producing microorganisms in synthetic or natural polymers is described, and gas prodn. with these immobilized cells is discussed. Subsequent application of the H to H-O **fuel-cell** system is also included. Immobilized bacteria, algae, and chloroplasts can be used for continuous prodn. of CH4 or H, and can be used in a H-O **fuel cell**. Employment of immobilized microorganisms and organelles made possible prolonged gas prodn. However, the power obtained was weak. Improvement of H productivity is needed for practical use in a H-O **fuel cell**. Therefore, mol. breeding of H-producing bacteria is important for practical application of a bioenergy conversion system.

ST review immobilized cell energy; polymer immobilization hydrogen microorganism review; methane microorganism polymer immobilization review; **fuel cell** microbial review

IT **Clostridium butyricum**
Cyanobacteria
(**fuel cells** using immobilized)

IT **Fuel cells**
(microbial, using immobilized **Clostridium butyricum** and blue-green algae)

IT 1333-74-0P, preparation
RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)
(manuf. of, by immobilized **Clostridium butyricum** and blue-green algae)

L2 ANSWER 11 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text Citing References

ACCESSION NUMBER: 1984:106578 CAPLUS
DOCUMENT NUMBER: 100:106578
TITLE: Biochemical energy conversion by immobilized whole cells
AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsuoka, Hideaki; Ueyama, Satoshi; Kawakubo, Hiroaki; Isoda, Satoshi; Murahashi, Toshiaki
CORPORATE SOURCE: Res. Lab. Resourc. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Annals of the New York Academy of Sciences (1983), 413(Biochem. Eng. 3), 133-43
CODEN: ANYAA9; ISSN: 0077-8923
DOCUMENT TYPE: Journal
LANGUAGE: English

AB H-producing bacteria, **Clostridium butyricum**, were immobilized in papers with agar (1.5%) gel. The immobilized whole cells (3 kg wet cells) were employed for continuous prodn. of H from molasses. The immobilized

whole cells continuously produced H (400-800 mL/min) over a 2-mo period. H produced was supplied to 2 H3PO4 **fuel cells** connected in parallel. About 10-12 W and a current of 10-12 A were obtained for 10 h. The energy balance of the bacterial **fuel-cell** system is also discussed.

ST **fuel cell** biochem; **Clostridium butyricum** hydrogen **fuel cell**; molasses **Clostridium butyricum** hydrogen manuf

IT **Fuel cells**
(bacterial, supplied with hydrogen produced continuously by immobilized whole cells of **Clostridium butyricum**, performance of)

IT **Clostridium butyricum**
(hydrogen manuf. from molasses by immobilized whole cells of, for **fuel cells**)

IT Molasses
(hydrogen manuf. from, by immobilized whole cells of **Clostridium butyricum**, for **fuel cells**)

IT 1333-74-0P, preparation
RL: PREP (Preparation)
(manuf. of, from molasses by immobilized whole cells of **Clostridium butyricum**, for **fuel cells**)

L2 ANSWER 12 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

| | |
|---|---|
| ACCESSION NUMBER: | 1982:126193 CAPLUS |
| DOCUMENT NUMBER: | 96:126193 |
| TITLE: | Photochemical **fuel cell** using immobilized chloroplast-**Clostridium butyricum** |
| AUTHOR(S): | Karube, I.; Suzuki, S.; Matsunaga, T.; Kayano, H. |
| CORPORATE SOURCE: | Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, Japan |
| SOURCE: | Adv. Biotechnol., [Proc. Int. Ferment. Symp.], 6th (1981), Meeting Date 1980, Volume 3, 389-94. Editor(s): Vezina, Claude; Singh, Kartar. Pergamon: Toronto, Ont. CODEN: 47GQAB |
| DOCUMENT TYPE: | Conference |
| LANGUAGE: | English |

TI Photochemical **fuel cell** using immobilized chloroplast-**Clostridium butyricum**

AB Spinach chloroplasts (Ch) and **Clostridium butyricum** (CB) were immobilized in 2% agar gel and used for light-induced H evolution system. Crude ferredoxin (8 μM) isolated from spinach was used as an electron carrier. The optimum conditions for immobilized chloroplasts were pH 8.0 and 30?. The activity of chloroplasts under anaerobic and N bubbling conditions was higher than that under aerobic conditions. H produced was applied to a H-O **fuel cell**. The photochem. **fuel cell** system comprised immobilized Ch and CB reactors and **fuel cell**. A photocurrent of 0.4-1.5 mA was obtained for 4 h, the conversion ratio of H to current being 80-100?.

ST **clostridium butyricum** hydrogen manuf; chloroplast hydrogen manuf; photochem **fuel cell** hydrogen oxygen; ferredoxin **clostridium butyricum** hydrogen manuf

IT **Clostridium butyricum**
(hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized chloroplast and, for **fuel cells**)

IT Chloroplast
(hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized

Clostridium butyricum and, for fuel
cells)

IT Ferredoxins
RL: USES (Uses)
(hydrogen manuf. from solns. contg., by agar gel-immobilized chloroplast and **Clostridium butyricum**, for **fuel cells**)

IT **Fuel cells**
(biochem., hydrogen-oxygen, hydrogen manuf. by agar gel-immobilized chloroplast-**Clostridium butyricum** for)

IT Energy
(solar, hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized chloroplast-**Clostridium butyricum** and, for **fuel cells**)

IT 1333-74-0P, preparation
RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)
(manuf. of, by agar gel-immobilized chloroplast-**Clostridium butyricum** from solns. contg. ferredoxin, for **fuel cells**)

L2 ANSWER 13 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1982:71800 CAPLUS
DOCUMENT NUMBER: 96:71800
TITLE: Photochemical energy conversion system using immobilized chloroplasts
AUTHOR(S): Kayano, Hiromichi; Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuichi
CORPORATE SOURCE: Res. Lab. Resour. Utilization, Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Biotechnology and Bioengineering (1981), 23(10), 2283-91
CODEN: BIBIAU; ISSN: 0006-3592
DOCUMENT TYPE: Journal
LANGUAGE: English

AB Immobilized chloroplasts and **Clostridium butyricum** were employed for a photochem. energy conversion system. Spinach chloroplasts were immobilized in 2% agar gel. The optimum temp. of immobilized chloroplasts was 30?. The max. activity was obtained in a phosphate buffer soln. (pH 8.0) contg. 8 μM ferredoxin under N bubbling condition. H was evolved under illumination by immobilized chloroplasts and C. butyricum. H produced by this system was applied to a H-O **fuel cell**. Photoinduced current was obtained from this photochem. energy conversion system. A photocurrent of 0.4-1.5 mA was continuously obtained for 4 h. The conversion ratio from H to current was 80-100%.

ST hydrogen manuf immobilized chloroplast; **Clostridium butyricum** immobilized hydrogen manuf; **fuel cell** biochem hydrogen oxygen

IT Chloroplast
**Clostridium butyricum**
(hydrogen manuf. by immobilized)

IT Fuel cells
(biochem., hydrogen-oxygen, performance of)

IT 1333-74-0P, preparation
RL: PREP (Preparation)
(manuf. of, by immobilized chloroplasts and **Clostridium butyricum**)

L2 ANSWER 14 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1981:553759 CAPLUS
DOCUMENT NUMBER: 95:153759
TITLE: Biochemical energy conversion by immobilized whole cells
AUTHOR(S): Karube, Isao; Suzuki, Shuichi; Matsunaga, Tadashi; Kuriyama, Shinichi
CORPORATE SOURCE: Res. Lab. Resources Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Annals of the New York Academy of Sciences (1981), 369(Biochem. Eng. 2), 91-8
CODEN: ANYAA9; ISSN: 0077-8923
DOCUMENT TYPE: Journal
LANGUAGE: English

AB H-producing bacteria, **Clostridium butyricum**, were immobilized in 2% agar gel, and the whole cells were employed for continuous H prodn. from the wastewater of an alc. factory. H was produced with a batch system. The whole cells continuously produced 20 mL H/min-kg wet gel over 1-mo period. H produced was supplied to a unit of 5 in-series connected H-O (air) **fuel cells** having a max. voltage of ~0.6 V/cell when H flow rate was 20 mL/min. The limiting c.d. changed from 0.4 to 40 mA/$cm^2$ as the resistance between the electrodes changed from 1 to 100 Ω. A current of 0.8 A and a total cell voltage of 2.2 V were obtained from the **fuel-cell** unit over a 10-day period.

ST **Clostridium butyricum** hydrogen manuf wastewater; **fuel cell** biochem hydrogen oxygen

IT **Clostridium butyricum**
(hydrogen manuf. by agar gel immobilized, from wastewater for **fuel cells**)

IT Wastewater
(winery, hydrogen manuf. by **Clostridium butyricum** from)

IT **Fuel cells**
(biochem., hydrogen-oxygen, hydrogen manuf. by immobilized **Clostridium butyricum** from wastewater for)

IT 1333-74-0P, preparation
RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)
(manuf. of, by agar gel immobilized **Clostridium butyricum** from wastewater for **fuel cells**)

L2 ANSWER 15 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1981:194921 CAPLUS
DOCUMENT NUMBER: 94:194921
TITLE: Biochemical energy conversion system
AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi; Kayano, Hiromichi
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Enzyme Engineering (1980), 5, 143-5
CODEN: ENENDT; ISSN: 0094-8500
DOCUMENT TYPE: Journal
LANGUAGE: English

AB A biochem. **fuel cell** system using immobilized whole cells of **Clostridium butyricum** and a photochem. **fuel cell** using immobilized chloroplasts and **Clostridium butyricum** are described. The biochem. **fuel cell** was left on for 7 days, and a current of 500-50 mA was

continuously obtained. The photochem. **fuel cell** was operated under illumination and a photocurrent of 170 μA was obtained for 2.5 h.

ST biochem **fuel cell clostridium butyricum**; photochem **fuel cell** clostridium butryicum; chloroplast photochem **fuel cell**

IT **Clostridium butyricum**
(biochem. and photochem. **fuel cells** contg. immobilized)

IT Chloroplast
(photochem. **fuel cells** contg. immobilized)

IT Ferredoxins
RL: USES (Uses)
(photochem. **fuel cells** contg. immobilized chloroplasts and)

IT **Fuel cells**
(biochem., with immobilized whole cells of **Clostridium butyricum**)

IT Photoelectric devices
(solar, biochem., with immobilized chloroplasts and **Clostridium butyricum**)

IT 330-54-1 13096-46-3
RL: USES (Uses)
(photochem. **fuel cells** contg. immobilized chloroplasts and)

L2 ANSWER 16 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1981:99214 CAPLUS
DOCUMENT NUMBER: 94:99214
TITLE: A specific microbial sensor for formic acid
AUTHOR(S): Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuich
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: European Journal of Applied Microbiology and Biotechnology (1980), 10(3), 235-43
CODEN: EJABDD; ISSN: 0171-1741
DOCUMENT TYPE: Journal
LANGUAGE: English

AB A microbial sensor consisting of immobilized **Clostridium butyricum**, 2 gas permeable Teflon membranes, and **fuel cell** type electrode was suitable for the detn. of formic acid. When the sensor was inserted into the sample soln. contg. formic acid, the current increases to a steady state with a response time of 20 min. The relation between the steady state current and the formic acid concn. is linear up to 1000 mg/L. The currents are reproducible with an av. relative error of 5%. Selectivity of the sensor is satisfactory. Results obtained with this sensor and by gas chromatog. were in good agreement when the cultivation medium of Aeromonas formicans was employed. Immobilized C. butyricum is stable for >20 days.

IT **Clostridium butyricum**
(immobilized, on electrodes for formic acid detn.)

L2 ANSWER 17 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1981:43980 CAPLUS
DOCUMENT NUMBER: 94:43980
TITLE: Some observations on immobilized hydrogen-producing bacteria: behavior of hydrogen in gel membranes
AUTHOR(S): Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuichi

CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Biotechnology and Bioengineering (1980), 22(12), 2607-15
CODEN: BIBIAU; ISSN: 0006-3592
DOCUMENT TYPE: Journal
LANGUAGE: English

AB An H2-forming bacterium, **Clostridium butyricum**, was immobilized in gel membranes that were exposed on 1 side to a glucose soln. as bacterial substrate, and the prodn. of H2 on the other side of the gel membrane was studied. Polyacrylamide gel, overall, was superior to agar gel and collagen membranes when mech. rigidity, glucose diffusion rate, and protection of bacterial viability were compared. The bacteria-polyacrylamide gel membrane is applicable as a microbial sensor because of its good diffusional and mech. properties. However, a whole cell-entrapped membrane electrode is not suitable for a **fuel cell**, because most of the H2 diffused to the substrate side, and not the electrode side, of the membrane.

ST immobilized Clostridium hydrogen; sensor polyacrylamide gel Clostridium; **fuel cell** Clostridium immobilized hydrogen

IT Membranes and Diaphragms
(gel, hydrogen prodn. by **Clostridium butyricum** immobilized in)

IT **Clostridium butyricum**
(hydrogen prodn. by, immobilized in gel membranes)

IT Electrodes
(bio-, gel membrane-immobilized **Clostridium butyricum** as)

IT **Fuel cells**
(biochem., gel membrane-immobilized **Clostridium butyricum** as hydrogen producer for)

L2 ANSWER 18 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1980:443917 CAPLUS
DOCUMENT NUMBER: 93:43917
TITLE: Biochemical energy conversion using immobilized whole cells of **Clostridium butyricum**
AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi; Kuriyama, Shinichi; Suzuki, Nobukazu; Shirogami, Tamotsu; Takamura, Tsutomu
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Biochimie (1980), 62(5-6), 353-8
CODEN: BICMBE; ISSN: 0300-9084
DOCUMENT TYPE: Journal
LANGUAGE: English

TI Biochemical energy conversion using immobilized whole cells of **Clostridium butyricum**

AB A H2-producing bacterium, **Clostridium butyricum**, was immobilized in 2% agar gel. The immobilized whole cells were employed for continuous prodn. of H2 from alc. factory waste waters. The H2 prodn. rate became const. at >BOD 1500 ppm when H2 prodn. was performed with a batch system. The immobilized whole cells continuously produced H2 over a 20-day period. The amt. of H2 produced was ~6 mL/min/kg wet gels. H2 produced was supplied to the H2-O2 (air) **fuel cells**. The max. cell voltage of cell I and II was ~55 and 0.66 V, resp., when the flow rate of H2 was 6 mL/min. The limiting c.d. changed from 0.4 to 40 mA/cm$^2$ as the resistance between the electrodes changed from 1 to 100 Ω. The **fuel cell**

was left on for 7 days and current of 550-500 mA was obtained continuously over a 7 day period.

ST hydrogen immobilized Clostridium; wastewater hydrogen **fuel cell**

IT Wastewater
(fermn. of, hydrogen prodn. by, with immobilized **Clostridium butyricum**)

IT **Fuel cells**
(hydrogen prodn. for, with immobilized **Clostridium butyricum**)

IT **Clostridium butyricum**
(immobilized, hydrogen prodn. from wastewater with)

IT 1333-74-0P, preparation
RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)
(manuf. of, for **fuel cells**, with immobilized **Clostridium butyricum**)

L2 ANSWER 19 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN order

Full Text | Citing References

ACCESSION NUMBER: 1979:460174 CAPLUS
DOCUMENT NUMBER: 91:60174
TITLE: Application of a biochemical **fuel cell** to wastewaters
AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan
SOURCE: Biotechnology and Bioengineering Symposium (1979), 8(Biotechnol. Energy Prod. Conserv.), 501-11
CODEN: BIBSBR; ISSN: 0572-6565
DOCUMENT TYPE: Journal
LANGUAGE: English

TI Application of a biochemical **fuel cell** to wastewaters

AB The performance of a biochem. **fuel-cell** system was evaluated. The system used in the study consisted of a wastewater reservoir, packed-bed reactor for immobilized **Clostridium butyricum**, Pt black anode, ion-exchange membrane, C cathode, and continuously stirred tank reactor for immobilized aerobic microorganisms. Industrial wastewaters were applied to the system. H prodn. by immobilized whole cells and wastewater treatment by immobilized microorganisms are discussed.

ST biochem **fuel cell** wastewater

IT Wastewater treatment
(biochem. **fuel cells** in)

IT **Clostridium butyricum**
(biochem. **fuel cells** with wastewater as nutrient for immobilized cells of)

IT **Fuel cells**
(biochem., with wastewater as nutrient for immobilized cells of Clostridium butyrium)

L2 ANSWER 20 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN order

Full Text | Citing References

ACCESSION NUMBER: 1978:76413 CAPLUS
DOCUMENT NUMBER: 88:76413
TITLE: Biochemical **fuel cell** utilizing immobilized cells of **Clostridium butyricum**
AUTHOR(S): Karube, Isao; Matsunaga, Tadashi; Tsuru, Shinya; Suzuki, Shuichi
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, Japan

SOURCE: Biotechnology and Bioengineering (1977), 19(11), 1727-33
CODEN: BIBIAU; ISSN: 0006-3592
DOCUMENT TYPE: Journal
LANGUAGE: English

TI Biochemical **fuel cell** utilizing immobilized cells of **Clostridium butyricum**

AB The anode reaction of a biochem. **fuel cell** which uses immobilized bacteria is described. A rolled Pt black anode and a C cathode were used. One side of the anode was covered with gel-entrapped microorganism (~0.1 cm thick). The anolyte was 250 mL of 0.1M phosphate buffer (pH 7.7) contg. 0.25M glucose. The catholyte was 100 mL of 0.1M phosphate buffer (pH 7.7). The temp. of the biochem. **fuel-cell** system was maintained at 37 ? 1?. From 1 mol glucose, 0.6 mol H and 0.2 mol HCO2H were produced by immobilized **Clostridium butyricum**. The current-potential relations of H and HCO2H are shown and discussed. A high-power biochem. **fuel cell** is possible by using bacteria which produce larger amts. of H or HCO2H than **Clostridium butyricum**.

ST biochem **fuel cell**; **clostridium butyricum fuel cell**

IT **Clostridium butyricum**
(**fuel cells** with immobilized, biochem., anode reaction of)

IT **Fuel cells**
(biochem., with immobilized **Clostridium butyricum**)

IT 7440-06-4, uses and miscellaneous
RL: USES (Uses)
(anodes, covered with gel-entrapped **Clostridium butyricum**, biochem. **fuel-cell**, reaction of)

L2 ANSWER 21 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1977:158235 CAPLUS
DOCUMENT NUMBER: 86:158235
TITLE: Conversion of natural products by biofuel cells
AUTHOR(S): Silverman, H. P.
CORPORATE SOURCE: Sci. Appl. Inc., La Jolla, CA, USA
SOURCE: AIChE Symposium Series (1976), 72(158), 49-51
CODEN: ACSSCQ; ISSN: 0065-8812
DOCUMENT TYPE: Journal; General Review
LANGUAGE: English

AB The use of glucose oxidn. urea conversion to NH3, and generation of HCO2H [64-18-6] by the action of Pseudomonas formicans on a carbohydrate source with subsequent electrochem. oxidn. of the HCO2H to CO2 in a **fuel cell** is reviewed. 10 Refs.

IT Aeromonas hydrophila formicans
(formic acid formation by, from carbohydrates, biochem. **fuel cell** in relation to)

IT **Clostridium butyricum**
(hydrogen prepn. by, from glucose, biochem. **fuel cell** in relation to)

IT Bacillus pasteurii
(urea decompn. to ammonia by, biochem. **fuel cell** in relation to)

IT **Fuel cells**
(biochem.)

IT 57-13-6, reactions
RL: RCT (Reactant); RACT (Reactant or reagent)
(decompn. of, biochem. **fuel cell** in relation to)

IT 50-99-7, reactions 64-18-6, reactions
RL: RCT (Reactant); RACT (Reactant or reagent)

(oxidn. of, biochem. **fuel cell** in relation to)

L2 ANSWER 22 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1973:157771 CAPLUS
DOCUMENT NUMBER: 78:157771
TITLE: Biochemical battery
AUTHOR(S): Suzuki, Shuichi
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Tokyo, Japan
SOURCE: Farumashia (1972), 8(2), 89-93
CODEN: FARUAW; ISSN: 0014-8601
DOCUMENT TYPE: Journal; General Review
LANGUAGE: Japanese

AB An electrode reaction composed of an electron transfer system in a biol. oxidn.-redn. reaction was explained with examples such as quinone-hydroquinone with oxidase, cystine-cysteine with Fe ion and glucose with ferricyanide or NADP. Electron transfer to the anode in cultures of **Clostridium butyricum** with glucose was an example of the use of microbial culture systems. Medical application of biol. **fuel cells** was suggested.

IT **Fuel cells**
(biol.)

L2 ANSWER 23 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text | Citing References

ACCESSION NUMBER: 1967:420597 CAPLUS
DOCUMENT NUMBER: 67:20597
TITLE: Biochemical **fuel cells**
AUTHOR(S): Brake, Jon M.
CORPORATE SOURCE: Magna Corp., Anaheim, CA, USA
SOURCE: NASA (Nat. Aeronaut. Space Admin.) Access. (1965), AD 619665, 190 pp.
From: Sci. Tech. Aerospace Rept. 1965, 3(22), N65-34166
CODEN: NAACAF
DOCUMENT TYPE: Report
LANGUAGE: English

TI Biochemical **fuel cells**

AB A summary of the first years of an investigation into biochem. **fuel cells** is presented. The systems investigated included the H producers, **Clostridium butyricum** and Escherichia coli, the NH3 producers, Bacillus pasteurii, urease, and L-amino acid oxidase, and the formic acid producers Aeromonas formicans and E. coli. The effects of temp., pH, ionic strength, and substrate on the rate of production of these fuels are reported. Electrochem. studies of the fuels were made under conditions compatible with their production. Formic acid proved to be the best choice. Current densities up to about 40 ma./cm.2 were obtained with this fuel. Formic acid was produced in practical quantities from sugar, coconut juice, fruit juices, and exts. of yams. A biochem. battery operating on coconut juice was used to operate a transistor radio intermittently over 45 days for a total of 50 hrs. The coulombic efficiency of the cell approached 100% of the formic acid produced.

ST ELEC BIOCHEM FUELS; **FUEL CELLS** BIOCHEM; MICROBIAL **FUEL CELLS**; BATTERIES BIOCHEM

IT **Fuel cells**
(biochem.)

L2 ANSWER 24 OF 28 USPATFULL on STN lyase Bad date

Full Text | Citing References

ACCESSION NUMBER: 2005:92806 USPATFULL
TITLE: Method for redesign of microbial production systems
INVENTOR(S): Maranas, Costas D., Port Matilda, PA, UNITED STATES
Burgard, Anthony P., State College, PA, UNITED STATES
Pharkya, Priti, State College, PA, UNITED STATES
PATENT ASSIGNEE(S): The Penn State Research Foundation, University Park, PA, UNITED STATES (U.S. corporation)

| | NUMBER | KIND | DATE | |
|---|---|---|---|---|
| PATENT INFORMATION: | US 2005079482 | A1 | 20050414 | |
| APPLICATION INFO.: | US 2004-929091 | A1 | 20040826 | (10) |

RELATED APPLN. INFO.: Continuation-in-part of Ser. No. US 2003-616659, filed on 9 Jul 2003, PENDING

| | NUMBER | DATE |
|---|---|---|
| PRIORITY INFORMATION: | US 2002-395763P | 20020710 (60) |
| | US 2002-417511P | 20021009 (60) |
| | US 2003-444933P | 20030203 (60) |

DOCUMENT TYPE: Utility
FILE SEGMENT: APPLICATION
LEGAL REPRESENTATIVE: MCKEE, VOORHEES & SEASE, P.L.C., ATTN: PENNSYLVANIA STATE UNIVERSITY, 801 GRAND AVENUE, SUITE 3200, DES MOINES, IA, 50309-2721, US
NUMBER OF CLAIMS: 18
EXEMPLARY CLAIM: 1
NUMBER OF DRAWINGS: 6 Drawing Page(s)
LINE COUNT: 1594
CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . and deletions, of microbial networks for the overproduction of targeted compounds. These compounds may range from electrons or hydrogen in bio-**fuel cell** and environmental applications to complex drug precursor molecules. A comprehensive database of biotransformations, referred to as the Universal database (with. . . .

DETD . . . Whited, 2003; Causey et al., 2004) or complex molecules such as carotenoids (Misawa et al., 1991), to electrons in bio **fuel cells** (Liu et al., 2004) or batteries (Bond et al., 2002; Bond et al., 2003) to even microbes capable of precipitating. . .

DETD . . . (see point A, in FIG. 3) leading to a growth-coupled production mode. Note that hydrogen production takes place through the **formate hydrogen lyase** reaction which converts formate into hydrogen and carbon dioxide under anaerobic conditions, in agreement with current experimental observations (Nandi &. . .

DETD . . . pyruvate which is then converted into formate through pyruvate formate lyase. Formate is catabolized into hydrogen and carbon dioxide through **formate hydrogen lyase**.

DETD . . . the lack of oxygen was preferred for hydrogen formation. Notably, it has been reported (Nandi & Sengupta, 1996) that although **formate hydrogen lyase** can only be induced in the absence of oxygen, it can function in aerobic environments. This will have to be. . . .

L2 ANSWER 25 OF 28 USPATFULL on STN

Full Text | Citing References

ACCESSION NUMBER: 2004:307100 USPATFULL

TITLE: Electrode compositions and configurations for electrochemical bioreactor systems
INVENTOR(S): Zeikus, Joseph Gregory, Okemos, MI, UNITED STATES
Park, Doo Hyun, Seoul, KOREA, REPUBLIC OF

| | NUMBER | KIND | DATE | |
|---|---|---|---|---|
| PATENT INFORMATION: | US 2004241771 | A1 | 20041202 | |
| APPLICATION INFO.: | US 2003-477273 | A1 | 20031112 | (10) |
| | WO 2002-US17143 | | 20020531 | |

| | NUMBER | DATE |
|---|---|---|
| PRIORITY INFORMATION: | US 2001-294943P | 20010531 (60) |
| | US 2001-338245P | 20011108 (60) |
| | US 2002-353037P | 20020130 (60) |

DOCUMENT TYPE: Utility
FILE SEGMENT: APPLICATION
LEGAL REPRESENTATIVE: MCLEOD & MOYNE, P.C., 2190 COMMONS PARKWAY, OKEMOS, MI, 48864
NUMBER OF CLAIMS: 46
EXEMPLARY CLAIM: 1
NUMBER OF DRAWINGS: 13 Drawing Page(s)
LINE COUNT: 1577
CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . R. Norris and D. W. Ribbons (eds.). Methods in Microbiology. Academic Press, New York, 1992; Bennetto, et al. "The Sucrose **Fuel Cell**: Efficient Biomass Conversion Using A Microbial Catalyst", Biotechnol. Lett. 7:699-105, 1985; Roller et al., "Electron-Transfer Coupling In Microbial **Fuel Cells**: 1. Comparison Of Redox-Mediator Reduction Rates And Respiratory Rates Of Bacteria", J. Chem. Tech. Biotechnol. 34B:3-12, 1984; and Thurston, et al., "Glucose Metabolism In A Microbial **Fuel Cell**. Stoichiometry Of Product Formation In A Thionine-Mediated Proteus Vulgaris **Fuel Cell** And Its Relation To Coulombic Yields". J. Gen. Microbial. 131:1393-1401,1985.). Chemical energy is converted to electric energy by coupling the. . . 247-283, In J. R. Norris and D. W. Ribbons (eds.). Methods in Microbiology. Academic Press, New York, 1992). In microbial **fuel cells**, two redox couples are required, one for coupling reduction of an electron mediator to bacterial oxidative metabolism, and the other. . . surface where the electron acceptor is regenerated with atmospheric oxygen (see, Ardeleanu, et al., "Electrochemical Conversion In Biofuel Cells Using **Clostridium Butyricum** Or Staphylococcus Aureus Oxford", Bioelectrochem. Bioenerg, 11:273-277, 1983; and Delaney, et al., "Electron-Transfer Coupling In Microbial **Fuel Cells**. 2. Performance Of **Fuel Cells** Containing Selected Microorganism-Mediator-Substrate Combinations", Chem. Tech. Biotechnol. 34b:13-27,1985).

SUMM . . . mediators such as 2-hydroxy-1,4-naphtoquinone (HNQ) or thionin (see, Tanaka et al., "Effects Of Light On The Electrical Output Of Bioelectrochemical **Fuel-Cells** Containing Anabaena Varibilis M-2: Mechanisms Of The Post Illumination Burst", Chem. Tech. Biotechnol. 42:235-240,1988; and Tanaka et al., "Bioelectrochemical **Fuel-Cells** Operated By The Cyanobacterium, Anabaena Variabilis", Chem. Tech. Biotechnol. 35B: 191-197, 1985). Park et al. in "Electrode Reaction Of Desulfovibrio. . . 1812:2403-2410, 1999), or converting microbial reducing power into electricity in biofuel cells (see, Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66:1292-1297, 2000). Park et al. in "Electricity Production In Biofuel Cell. . . Biotech. Lett. 22:1301-1304, 2000 showed that binding neutral red to a graphite

electrode further enhanced electron transfer efficiency in microbial **fuel cells**.

SUMM . . . Electron Donor For Growth And Metabolite Production", Appl. Environ. Microbiol. pp. 2912-2917, 1990; Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red As An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000; and U.S. Pat. No. 6,270,649).

SUMM . . . bacterial cultures. In one specific application, there is a need for an improved electrode that has utility as an enzymatic **fuel cell**, as a sensor for succinate detection, and as an engineered catalyst for the synthesis of fumarate or succinate. In particular,. . .

SUMM . . . contains bacterial cells, electron mediator, and reduced substrate (see, for example, Ardeleanu, et al., "Electrochemical Conversion In Biofuel Cells Using **Clostridium Butyricum** Or Staphylococcus Aureus Oxford", Bioelectrochem. Bioenerg, 11:273-277, 1983; and Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66:1292-1297, 2000). Two compartment **fuel cells** are generally not practical because of the requirement for a ferricyanide solution and aeration in the cathode compartment. Thus, there. . .

SUMM . . . of the present invention to provide an electrochemical bioreactor system having an improved electrode that has utility as an enzymatic **fuel cell**.

SUMM [0025] It is yet another advantage of the invention to provide a **fuel cell** system that can be used as either an enrichment device for electrophilic microorganisms; that is, those which use an electrode. . .

DRWD [0029] FIG. 3 is a schematic diagram of a single compartment **fuel cell** according to a third aspect of the invention depicting electron transfer from cell metabolism to the anode metals to the. . .

DRWD [0030] FIG. 4 is a diagrammatic representation of the single compartment **fuel cell** of FIG. 3. The single compartment **fuel cell** comprises a Pyrex.TM. glass container (total volume 500 ml.) with a $Fe^{3}+$ cathode (50 $cm^2$ surface area) and a rubber. . .

DRWD . . . 5 is a comparison of electrical current and potential levels obtained when Escherichia coli was used in a two compartment **fuel cell** (A, B and C) versus a single compartment **fuel cell** (D, E and F). Three different types of anode and cathode combinations were applied to each **fuel cell** system. (A) and (D) were a woven graphite anode and a, $Fe^{3}+$ graphite cathode; (B) and (E) were a neutral. . .

DRWD . . . 6 is a comparison of electrical current and potential levels obtained when sewage sludge was used in a two compartment **fuel cell** (A, B and C) versus a single compartment **fuel cell** (D, E and F). Three different types of anode and cathode combinations were applied to each **fuel cell** system. (A) and (D) were a woven graphite anode and a $Fe^{3}+$ graphite cathode; (B) and (E) were a woven. . .

DETD . . . shown a schematic that depicts how the CMC-NR-NAD+-fumarate reductase enzyme immobilized onto the graphite felt electrode can function as a **fuel cell** during succinate oxidation and as a catalyst producing succinate from electricity and fumarate. The oxidation of succinate to fumarate coupled. . .

DETD . . . also dependent on current and fumarate concentration. This electrochemical bioreactor system can enhance the utility of oxidoreductases in diverse enzymatic **fuel cells**, chemical synthesis and chemical detection.

DETD . . . electrochemical bioreactor system is shown in FIGS. 3 and 4. FIG. 3 provides a schematic of how the single compartment **fuel cell** works. Bacteria attach to the anode and electrons are transferred from the cells metabolic pool to reduce either neutral red. . .

DETD [0063] The cathodes differed from the anodes in the single compartment **fuel cell** because the inside of the cathode was coated with a 1 millimeter thickness porcelain septum made from 100% kaolin. The. . .

DETD **Fuel Cell** Design And Operation

DETD [0064] Two compartment cell **fuel cells** were prepared using the configuration described in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000, except for using the electrodes prepared in Example 2;. . . mm by 2 mm thick porcelain septum made from 100% Kaolin as described above in Example 2. The two compartment **fuel cell** of Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000 requires aeration and ferricyanide solution in the cathode compartment.

DETD [0065] Because two compartment **fuel cells** are generally not practical because of the requirement for a ferricyanide solution and aeration in the cathode compartment, single compartment **fuel cell** design as shown in FIGS. 3 and 4 was prepared in order to eliminate the requirements for a ferricyanide solution and aeration in the cathode compartment. FIG. 3 provides a schematic of how the single compartment **fuel cell** works. Bacteria attach to the anode and electrons are transferred from the cells metabolic pool to reduce either neutral red. . . sewage sludge using soluble neutral red and a plain, woven graphite electrode (See, Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000).

DETD . . . Resting cell suspensions in anolyte medium I were placed in the anoxic anode compartment of the two versus one compartment **fuel cell** systems and electrical current and potential were measured as reported in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000. Experiments compared electrical performance of E. coli versus sewage sludge in two versus one compartment **fuel cells** that contained different electrode compartments for the anode and cathode. The electrical measurements used a joule as the unit of. . . system per time unit. For calculations of the joule value, the current, potential and time were all measured in the **fuel cells** employed.

DETD Single Compartment **Fuel Cell**--Electricity Production By E. Coli

DETD [0067] FIG. 5 compares electricity generation by E. coli in a two compartment **fuel cell** as prepared as described above (A, B and C) versus a single compartment **fuel cell** as prepared as described above (D, E, and F) with different electrode compositions. Potential was higher in the two compartment **fuel cell**; whereas current wasp equivalent in either **fuel cell** system. Current was significantly lower when a woven graphite anode and a $Fe^{3}+$ graphite cathode were used. Notably, nearly equivalent. . . obtained when either a neutral red woven graphite anode or a Mn+4 graphite anode were used as electrodes in either **fuel cell** system with a $Fe^{3}+$ graphite cathode.

DETD . . . using the neutral red-woven graphite electrode developed here versus the system described in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000 using soluble neutral red and a woven graphite as. . .

DETD . . . by sewage sludge microbes in a two compartment fuel call as prepared above (A, B, C) versus a one compartment **fuel cell** as prepared above (D, E, F). Current was higher in the single compartment **fuel cell** than the two compartment **fuel cell** with all anode-cathode combinations tested; whereas, the potential was nearly equivalent. Sewage sludge bacteria produced significantly higher current levels than. . .

DETD [0070] After the experiments were finished, the anode was removed from the one compartment **fuel cell** and examined it by scanning electron microscopy (see FIG. 7). Sample preparation and scanning electron microscopy investigation were performed at. . . for Advanced Microscopy, East Lansing, Mich., USA. The graphite felt was removed at the end of the experiment in the **fuel cell** containing sewage sludge and glucose. The graphite felt electrode sample (cut from electrode surface 55ı5ı mm) was fixed in 4%. . .

DETD [0071] Practical improvements have been demonstrated in both microbial **fuel cell** designs and enhanced microbial electron transfer efficiencies with new cathode and anode compositions. The new single compartment **fuel cell** system offers advantages over a conventional two compartment **fuel cell**. First, the new single compartment **fuel cell** system is simpler and less expensive to construct and operate, Second, the single compartment **fuel cell** system eliminates the need for a ferricyanide catholyte and aeration which might use more energy than the **fuel cell** makes, Third; the single compartment **fuel cell** system replaces the expensive proton selective membrane with a porcelain septum. Fourth, the use of a Fe+3 graphite cathode enhances. . .

DETD . . . the different potential and current levels obtained when different anode and cathode configurations were used to produce electricity in microbial **fuel cells** using either E. coli or anaerobic sewage sludge. In general, the over-all electron driving force is directly related to the. . .

DETD [0073] Previously, soluble electron mediators were used in **fuel cells** such as neutral red, thionin, and 2-hydroxyl-1,4-naphtoquinone to convert microbial reducing power into electricity. Most soluble electron donors except for. . . as well or better than a neutral: red woven graphite in coupling electron transfer from microbes to electricity production in **fuel cells**. In sum, these two new anode compositions significantly enhanced electron transfer efficiencies in microbial **fuel cells** from that reported previously.

DETD [0074] Resting cells in the new **fuel cell** system described here were using lactate as the electron donor and the anode as the electron acceptor for energy metabolism.. . .

DETD . . . cathode) as the electron donor while reducing $CO_2$ as the electron acceptor (see, Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000). Kim et al. in "Direct Electrode Reaction Of Fe(III)-Reducing. . .

DETD . . . intending to be bound by theory, it is believed that the $Mn^{4}$+ graphite and the neutral red-woven graphite electrodes and **fuel cells** described herein may prove useful as "lightning rods" for the enrichment of electrophiles.

DETD . . . 0.2204
with electricity

[a]initial fumarate concentration used was 60 mM

[b]which were extracted as in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66: 1292-1297, 2000.

Resting cells were obtained from 16 hour cultivated. . .

DETD . . . rate of electron transfer from cells. The electrochemical bioreactor system has an improved electrode that has utility as an enzymatic **fuel cell**, as a sensor for succinate detection, and as an engineered catalyst for the synthesis of fumarate or succinate. The electrochemical. . .

L2 ANSWER 26 OF 28 USPATFULL on STN INSTANT APP.

Full Text | Citing References

ACCESSION NUMBER: 2002:235255 USPATFULL
TITLE: Polymer electrolyte **fuel cell**
INVENTOR(S): Yamamoto, Noriyuki, Kashiba-shi, JAPAN
Katoh, Nobuo, Kameoka-shi, JAPAN
Yukawa, Hideaki, Kyoto-shi, JAPAN

| | NUMBER | KIND | DATE | |
|---|---|---|---|---|
| PATENT INFORMATION: | US 2002127440 | A1 | 20020912 | |
| APPLICATION INFO.: | US 2002-87994 | A1 | 20020305 | (10) |

| | NUMBER | DATE |
|---|---|---|
| PRIORITY INFORMATION: | JP 2001-62403 | 20010306 |

DOCUMENT TYPE: Utility
FILE SEGMENT: APPLICATION
LEGAL REPRESENTATIVE: NIXON & VANDERHYE P.C., 8th Floor, 1100 North Glebe Road, Arlington, VA, 22201
NUMBER OF CLAIMS: 7
EXEMPLARY CLAIM: 1
NUMBER OF DRAWINGS: 1 Drawing Page(s)
LINE COUNT: 447
CAS INDEXING IS AVAILABLE FOR THIS PATENT.

TI Polymer electrolyte **fuel cell**

AB A polymer electrolyte **fuel cell** includes a housing provided with an anode-side supply inlet for supplying a material for fuel, an anode and a cathode. . . .

SUMM [0003] The present invention relates to a polymer electrolyte **fuel cell**. More particularly, in the polymer electrolyte **fuel cell**, an oxygen-containing hydrocarbon is introduced as a material for fuel from a supply section for supplying the material for fuel,. . . . a biochemical catalyst to generate hydrogen as fuel before the material for fuel reaches an anode of the polymer electrolyte **fuel cell**, and the generated hydrogen is supplied to the anode.

SUMM [0005] A **fuel cell** is provided with a cathode and an anode on both sides of an electrolyte. The cathode (oxidizer electrode) is supplied. . . .

SUMM [0006] **Fuel cells** are classified into a number of groups such as alkaline **fuel cells**, acid **fuel cells**, molten carbonate **fuel cells**, solid oxide **fuel cells** and polymer electrolyte **fuel cells** (PEFCs) according to their types of electrolytes. Of these **fuel cells**, the PEFCs have proton-conductive solid polymers as electrolytes and are systems using high-purity hydrogen gas as fuel.

SUMM [0009] On the other hand, direct methanol-air **fuel cells** (DMFCs) are directly supplied with methanol as fuel. Since they can use proton-conductive polymers as electrolytes, the DMFCs can possibly. . . .

SUMM [0010] Direct methanol-air **fuel cells** using proton-conductive polymer membranes as electrolytes (PEM-DMFCs) have a structure in which porous electrodes carrying electrocatalysts are formed on both. . . .

SUMM . . . . produced by such bacteria, an example is reported in which the produced hydrogen is supplied to the anode of a **fuel cell** and the amount of generated electricity is measured. However, this is not put into practical use as a polymer electrolyte **fuel cell** (Japanese Unexamined Patent Publication No. HEI 7(1995)-218469).

SUMM [0017] Accordingly, there is a demand for a polymer electrolyte **fuel cell** which uses an oxygen-containing hydrocarbon such as methanol as a

material for fuel and can generate electricity at low temperatures. . .

SUMM [0018] An object of the present invention is to provide a polymer electrolyte **fuel cell** wherein a supplied oxygen-containing hydrocarbon is passed through a layer containing a biochemical catalyst comprised of a hydrogen-generative anaerobic bacterium,. . . the oxygen-containing hydrocarbon is decomposed to produce hydrogen, which is supplied as fuel to the anode of the polymer electrolyte **fuel cell**.

SUMM [0019] The present invention provides a polymer electrolyte **fuel cell** comprising a housing provided with an anode-side supply inlet for supplying a material for fuel; an anode and a cathode. . .

SUMM [0020] Further the present invention provides a polymer electrolyte **fuel cell** comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel, the anode-side supply inlet being. . .

DRWD [0022] Fig. 1 is a schematic sectional view of a polymer electrolyte **fuel cell** whose anode-side collector is also used as a biochemical catalyst layer in accordance with the present invention; and

DRWD [0023] FIG. 2 is a schematic sectional view of a polymer electrolyte **fuel cell** provided with a filter containing a biochemical catalyst layer for decomposing a hydrocarbon within a fuel supply path before the. . .

DETD [0024] The housing for accommodating the polymer electrolyte **fuel cell** usable in the present invention may be one formed of an electrically insulative resin such as acrylic resin, polypropylene resin,. . .

DETD . . . for supplying the material for fuel includes all members used for supplying the material for fuel to the polymer electrolyte **fuel cell**. For example, the supply section includes a pipe for connecting the supply inlet to a generator which generates the material. . . where the supply section is formed integrally with the housing, the supply section is a part of the polymer electrolyte **fuel cell**, and the polymer electrolyte **fuel cell** as a whole becomes smaller in size and simpler in shape. On the other hand, in the case where the. . . inlet of the housing, the supply section is attached to the housing via the supply inlet when the polymer electrolyte **fuel cell** is used, and the supply section can be detached when the supply section is not required. Therefore, it is also possible to reduce the size of the polymer electrolyte **fuel cell**. An inlet for supply an oxidizer may also be provided on a cathode side of the housing.

DETD . . . for fuel is one or more species selected from the group consisting of hydrogen-generative anaerobic bacteria such as Clostridia (e.g., **clostridium butyricum**, clostridium acetobutylicum), Lactobacilli (e.g., Lactobacillus pentoaceifus), and photosynthetic bacteria including Rhodospirilli (e.g., Rhodospirillum rubrum) and Rhodopseudomonas (e.g., Rhodopseudomonas spheroides); hydrogen-generative yeasts such as methylotrophic yeast; and hydrogen-generative enzymes such as methanol-assimilating enzyme, methanol dehydrase and **formate-hydrogen lyase**. Among these biochemical catalysts, a combination of **clostridium butyricum** and **formate-hydrogen lyase** is preferred.

DETD [0030] In the present invention, the layer containing the biochemical catalyst may be located within the **fuel cell**, i.e., between the anode and the supply inlet on the anode side for supplying the material for fuel, or may. . . for fuel. More particularly, in the case where the layer exists between the anode and the supply inlet within the **fuel cell**, the layer may be in the form of a filter in the supply inlet, or may also serve as an anode-side collector of the **fuel cell**. In the case where the layer exists within the supply section, the layer may be in the form of a. . . the layer in the supply

section which is formed integrally with or separately from the housing of the polymer electrolyte **fuel cell**.

DETD . . . For example, if the biochemical catalyst is a combination of a hydrogen-generative anaerobic bacterium belonging to the genus Clostridium and **formate-hydrogen lyase**, the material for fuel is preferably methanol.

DETD . . . formic acid, which is formate-ionized. The generated formate ions produce hydrogen and carbon dioxide gas due to the action of **formate-hydrogen lyase**. ##STR1##

DETD [0035] The produced hydrogen is then supplied to the anode of the polymer electrolyte **fuel cell**, where hydrogen is oxidized to produce protons and electrons. The resulting protons migrate through the electrolyte toward cathode. On the. . . through an external circuit, producing an electric current. The produced carbon dioxide gas is discharged to the outside of the **fuel cell** system together with excess fuel.

DETD [0038] A polymer electrolyte **fuel cell** was produced as follows. Platinum was made carried by 5 g of carbon in an amount of 10 wt %.. . . resulting electrolyte membrane, an anode-side collector 6 and a cathode-side collector 7 were formed of carbon fiber. The polymer electrolyte **fuel cell** was accommodated in a housing (A)1 and a housing (B)2 which were formed of an acrylic resin which was an. . . were located on the outer sides of the anode 4 and the cathode 5. A mixture liquid, 3 mL, of **formate-hydrogen lyase** and **Clostridium butyricum** cultivated using a liquid medium ATOC38 of a starting pH 8.0 at 30? C. for 10 days was put and. . .

DETD [0039] A polymer electrolyte **fuel cell** is produced in the same manner as Example 1 except that the bacterium and the enzyme were not used for the anode-side collector 6. Further the polymer electrolyte **fuel cell** of Example 2 was provided with a filter 18 connected to the supply inlet 8 for the material for fuel. . . by a connection pipe 17. The filter 18 was formed of the same material as the collectors 6 and 7. **Clostridium butyricum** and **formate-hydrogen lyase** were fixed in part of the filter by the aforesaid method. (see FIG. 2).

DETD [0040] A polymer electrolyte **fuel cell** is produced in the same manner as Example 1 except that the bacterium and the enzyme were not used for. . .

DETD Evaluation Test of polymer electrolyte **fuel cells**

DETD . . . aqueous solution of methanol was fed via the supply inlet 8 for the material for fuel of the polymer electrolyte **fuel cell** of Example 1. When the aqueous solution of methanol passed through the anode-side collector, hydrogen and carbon dioxide gas were generated due to the action of **Clostridium butyricum** and **formate-hydrogen lyase**. Carbon dioxide gas was discharged from the fuel discharge outlet 9 to the outside of the polymer electrolyte **fuel cell** together with excess hydrogen. On the other hand, the generated hydrogen was fed to the anode 4, and was ionized. . . with oxygen ions to produce water on the cathode side. Electrons generated during this reaction are taken out of the **fuel cell** system, whereby electricity was generated constantly for 5 hours.

DETD . . . An aqueous solution methanol was fed via the supply inlet 8 for the material for fuel of the polymer electrolyte **fuel cell** of Reference Example 1. The resulting generation of electricity declined gradually, and stopped after three hours.

DETD [0043] As clearly seen from the examples and reference example, the polymer electrolyte **fuel cell** of the present invention generated electricity more efficiently than the ordinary methanol **fuel cell** which used an oxygen-containing hydrocarbon as fuel but did not use biochemical catalysts. According to the present invention, since carbon. . . the anode, the poisoning of platinum, ruthenium or the like used

for the anode catalyst can be avoided. Further the **fuel cell** can work at low temperatures.

CLM What is claimed is:

1. A polymer electrolyte **fuel cell** comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel; an anode and a cathode. . .

2. A **fuel cell** according to claim 1 further comprising an anode-side collector and a cathode-side collector which sandwich the anode and the cathode. . .

3. A polymer electrolyte **fuel cell** comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel, the anode-side supply inlet being. . .

4. A **fuel cell** according to claim 1 or 3, wherein the biochemical catalyst comprises one or more selected from hydrogen-generative anaerobic bacteria, hydrogen-generative. . .

5. A **fuel cell** according to claim 1 or 3, wherein the biochemical catalyst comprises a combination of **Clostridium butyricum** and **formate-hydrogen lyase**.

6. A **fuel cell** according to claim 1 or 3, wherein the material for fuel is selected from oxygen-containing hydrocarbons such as alcohols, polysaccharides,. . .

7. A **fuel cell** according to claim 1 or 3, wherein the material for fuel is in the form of an aqueous solution.

L2 ANSWER 27 OF 28 USPATFULL on STN

Full Text | Citing References

| | | | | |
|---|---|---|---|---|
| ACCESSION NUMBER: | 2002:154697 USPATFULL | | | |
| TITLE: | Integrated anaerobic digester system | | | |
| INVENTOR(S): | Ainsworth, Jack L., Canton, TX, UNITED STATES<br>Atwood, Dan, Nassau Bay, TX, UNITED STATES<br>Rideout, Tom, Midland, TX, UNITED STATES | | | |
| | NUMBER | KIND | DATE | |
| PATENT INFORMATION: | US 2002079266 | A1 | 20020627 | |
| | US 6569332 | B2 | 20030527 | |
| APPLICATION INFO.: | US 2001-963130 | A1 | 20010924 | (9) |
| RELATED APPLN. INFO.: | Continuation-in-part of Ser. No. US 2000-602684, filed on 26 Jun 2000, PATENTED | | | |
| DOCUMENT TYPE: | Utility | | | |
| FILE SEGMENT: | APPLICATION | | | |
| LEGAL REPRESENTATIVE: | INNOVAR, LLC, P O BOX 250647, PLANO, TX, 75025 | | | |
| NUMBER OF CLAIMS: | 79 | | | |
| EXEMPLARY CLAIM: | 1 | | | |
| NUMBER OF DRAWINGS: | 5 Drawing Page(s) | | | |
| LINE COUNT: | 1483 | | | |

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . engine, a water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, **fuel cell**, or various components of the system itself and/or to recharge power cells; (12) the gas processor comprises a gas scrubber. . .

DRWD . . . barkeri (methane), Ms. vacuolata (methane), Propionibacterium acidi-propionici (methane), Saccharomyces cerevisae (ethanol), S. ellipsoideus (ethanol), Clostridium propionicum (propanol), Clostridium saccharoacetoper-butylicum (butanol), **Clostridium butyricum** (hydrogen), wherein the chemical in parentheses indicates a useful material which that microbe produces.

CLM What is claimed is:

. . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

. . . combustion engine, electrical current generator, electric engine, water heater, furnace, air conditioning unit, ventilation fan, conveyor, pump, heat exchanger, and **fuel cell**.

. . . Alcaliphilum, Ms. acetivorans, Ms. thermophilia, Ms. barkeri, Ms. vacuolata, Propionibacterium acidi-propionici, Saccharomyces cerevisae, S. ellipsoideus, Clostridium propionicum, Clostridium saccharoacetoper-butylicum, and **Clostridium butyricum**.

. . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

. . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

. . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

. . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

L2 ANSWER 28 OF 28 USPATFULL on STN

Full Text | Citing References

| | |
|---|---|
| ACCESSION NUMBER: | 2001:173040 USPATFULL |
| TITLE: | Anaerobic digester system |
| INVENTOR(S): | Ainsworth, Jack L., 2419 VZ Cr 2318, Canton, TX, United States 75103<br>Atwood, Dan, 2746 Lighthouse Dr., Nassau Bay, TX, United States 77058<br>Rideout, Tom, 4106 S. CR 1185, Midland, TX, United States 79706 |

| | NUMBER | KIND | DATE | |
|---|---|---|---|---|
| PATENT INFORMATION: | US 6299774 | B1 | 20011009 | |
| APPLICATION INFO.: | US 2000-602684 | | 20000626 | (9) |

| | |
|---|---|
| DOCUMENT TYPE: | Utility |
| FILE SEGMENT: | GRANTED |
| PRIMARY EXAMINER: | Simmons, David A. |
| ASSISTANT EXAMINER: | Prince, Fred |
| LEGAL REPRESENTATIVE: | Matos, RickInnovar, L.L.C. |
| NUMBER OF CLAIMS: | 31 |
| EXEMPLARY CLAIM: | 1 |
| NUMBER OF DRAWINGS: | 4 Drawing Figure(s); 4 Drawing Page(s) |
| LINE COUNT: | 959 |

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . operate a water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, **fuel cell**, or various components of the system itself and/or to recharge power cells; (12) the gas processor comprises a gas scrubber. . .

DETD . . . barkeri (methane), Ms. vacuolata (methane), Propionibacterium acidi-propionici (methane), Saccharomyces cerevisae (ethanol), S. ellipsoideus (ethanol), Clostridium propionicum (propanol), Clostridium saccharoacetoper-butylicum (butanol), **Clostridium butyricum**

(hydrogen), wherein the chemical in parentheses indicates a useful material which that microbe produces.

CLM What is claimed is:

. . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.

. . . . combustion engine, electrical current generator, electric engine, water heater, furnace, air conditioning unit, ventilation fan, conveyor, pump, heat exchanger, and **fuel cell**.

. . . . Alcaliphilum, Ms. acetivorans, Ms. thermophilia, Ms. barkeri, Ms. vacuolata, Propionibacterium acidi-propionici, Saccharomyces cerevisae, S. ellipsoideus, Clostridium propionicum, Clostridium saccharoacetoper-butylicum, and **Clostridium butyricum**.

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